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Review Paper

Smart Generation of 6G: Opportunities and Challenges

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Abstract

Every ten years there has been a generation shift in communication. Although sixth generation wireless systems, which refer to as going beyond fifth generation (5G) systems are just starting to become a commercial reality. The newest innovations and cutting edge breakthrough in telecommunication network throughout previous period. The "Smart Generation of 6G" refers toward create and utilization for advanced technology, strategies, and frameworks that define Following a wave of technological advances in wireless communication, often referred to be the sixth generation. This conceptual encompasses the integration of various cutting-edge technology like quantum technology and intelligent machines, advanced signal processing, even innovative networking architectures to establish a highly intelligent, efficient, and responsive wireless network ecosystem. The "Smart Generation of 6G" encapsulates the forward-looking paradigm shift towards an intelligent, interconnected, and transformative communication landscape that will redefine industries, enable new applications, and drive unprecedented socio-economic progress. In this section, we provide a thorough analysis regarding the most lately advancements toward the sixth generation. While doing so emphasize both technical as well as social developments driving transition upwards of the sixth generation. Subsequently, new uses for meet the requirements generated Driven patterns using the sixth generation include examined. Additionally, I go into detail about the prerequisites needed to implement 6G apps. Then we thoroughly outline the major enabling technologies. Smart Generation of 6G focuses on the following key aspects: Ubiquitous Connectivity, Hyper-Fast Transmission Speeds and incredibly low Latencies, Intelligent Networking, Energies efficiency and Wavelength Analysis, Security as well as Privacy, Heterogeneous Integration, Global Collaboration And it has explain how the next generation of mobile network and the latest technology IoE are evolving and convergent leading to the birth dynamic 6th generation networks that will apply Artificial Intelligence, optimise, automate , solve challenges and opportunities.

Keywords: 6G, IoT, ML, AI.

Introduction

We must look into 6G network even thought 5G technology hasn't yet reached its full Potential. Leading communication experts from across the global worked together to publish the first 6G. In an informal sense, this step formally created 6G as research area. More and more government and nongovernment organisation are announcing their involvement in 6G research. Globally, government that focused latest model idea investing in dynamic 6th Generations ''6 genesis'' that seeks to identify the most effective techniques for creating 6G network. There are many potential applications in the 6G Network, without any fixed standards or specification. Some contend that 6G Network should be an entire advancement of 5G technologies rather than just quicker version of 5G networks. Despite its limitations, the previous generation network not limited to the ground for coverage reason. Surface under the sea must to be entirely covered. The next generation will also have considerably more sophisticated AI.

According to many academics the next generation network considers both of AI-Driven and AI- enable making AI its defining attribute. The ability to deliver function that is totally automation services and impressive won't be possible with 5G networks. Even thought the previous generation communication system will have many choices over the over the current ten year from now it won't be able to support concepts that are intelligent and automate. The previous generation offer latest capability give a higher level services compared to 4G communications. New feature of 5G technology include more frequency band improved spectrum management strategies and blending of licence and unlicensed bands[1].

Evolution of wireless communication

1G: A new age of mobile communication began with 1G. Bell labs first put forth the concept for the cellular network in 1947. One of the first mobile phone the ''DynaTAC'' as released by Motorola in the early1980 to offer the 1G mobile communication service.

TACS (Total Access Communication System) which is utilised Inside of the union state TZ-801/2/3 are both used in North America, Which is Japan utilizes are just a few the 1G standards that various nation have developed. 1G solely provided voice call services and employed analogue communication technology using carrier frequency of roughly 150MHz. Although it open up new possible for eliminating the physical barrier to inter-person communication technology the quality of the communication and the level of security were quite low. Additionally because each nation created its own system several mobile communication system were incompatible with each other[2].

2G: A new age of digital mobile communication began with 2G. The commitment if virtual conversation technology instead of analogue ones was the main change from 1G. In 2G the strength of digital systems communication technology have substantially increased both the security level and the quality of communication. 2G offered more activities that go beyond phone interactions only between peoples. Which makes that communication possible of digital secured message including text (SMS), Photo message and multimedia message in additions to voice conversation? The variety of message formats improved commercial option this concluded in an explosion when utilizing of mobile communication gadgets during this time. The 1991 launch of the worldwide wireless network (GSM), was first 2G usual. The GSM which later became General Mobile, Supported data rate of 9.6kbit/s. expanded which provided highest transmission rate of 40kbit/s and 384kbit/s respective. 2G Standards in Time Division Multiple Access technology based on GSM were used (TDMA)[3].

3G: The cellular broadband age began with 3G. A crucial breakthrough of 3G was the launch of information packet-based telecommunication. The mobile internet often knows as the World Wide Web could be accessed using mobile communication systems from any location in the world by the packet switched communication technologies. In comparison to 2G, 3G's highest data was about 2 Mbps which is roughly four timers quicker. New services like voice over IP (Like Skype) quick online browsing and video streaming were made available because to this time period, including the Blackberry in 2002 and the iPhone in 2007. The mobile communication system services capabilities were enhanced by this gadget. In accordance with internet mobile Equipment Standardized Universal, 3G was created IMT-2002 telecommunication standards. NTT Do Como introduce the first 3G services in 2001 using the Third Gen Collaboration Initiative standardized All-Inclusive Cell Telecommunication Structure (UMTS) system (3GPP). Uplink and download link peak data rates for this system's successor, HSPA+ has a maximum speed of 28mbit/s. The Code Division Multiple Access (CDMA) 2000 technology is the 3GPP2 norm with regard to 3G technology, which is highly profitable technology towards the Northeast American and Korean. EVDO Rev B Protocol which was the successor standard increased maximum downlink transmission rate of 14.7Mbit/s[4].

Table-1: Development towards wireless technology 1G to 6G

Era	Velocity	Innovation	Important feature
1st G (1970-1980)	14.4kbps	AMPS, NMT, TACS	Voice only service.
2nd G (1990-2000)	9.6/14.4Kbps	TDMA, CDMA	Voice and data Service.
2.5thG – 2.75thG (2001-2004)	20–40kbps at 171.2 kbps	GPRS	Phone, data and mobile, internet services as well as email and slow streaming services.
3rdG (2004-2005)	3.1Mbps 500-700kbps	CDMA200 (1*RTT, EVDO) UMTS and EDGE	Talk, Data, Multimedia, smart phone support, Quicker Television broadcasting, phone calls, as well as web surfing.
3.5thG (2006-2010)	14.4Mbps 1-3 Mbps	HSPA	Utterly all services increased speed and mobility with the 3G network.
4thG (2006–2010)	100 to 300Mbps, 3 to 5 Mbps, and 100Mbps (wifi)	WiMax, LTE, and Wi-Fi	There is access to 3D playing games, Uhd video conferences, fast speeds, excellent audio through IP, plus worldwide travel.
5thG (Starting 2020)	1 to 10Gbps	Advanced LTE Protocol, OMA and NOMA	High-speed Connectivity on the go, a connection with minimal delay in vital applications, IoT, Monitoring & safety, high-definition streaming multimedia and application for independent vehicles and intelligent medical care.
6thG (Expected early 2030)	Max. Speed Up1 Tbps	AI, OWC, 3D networking, UAV, wireless power transfer and terahertz (THz) band	Assistive technology, Immersive AR/VR, Advance AI, Autonomous vehicles, Decentralized businesses.

4G: The era of broadcasting on actual time began with 4th generations. The main difference between 3G and 4G was the availability of significantly improved data hundred of mbps/s or more. Latest smart phone services included increasing mobile TV and actual mobile games, were driven by this data rate improvement. Multi-Access with Opposite Phase Splitting constitutes new type of data transmission was key technology as a increasing and data speeds (OFDMA). The data speeds were also significantly increased by means of MIMO (Multiple – input Multiple- output) communication technique. Interfering with faded channels issues within this warless environment must be addressed, these two essential technologies radically altered the design concept of cellular networks. 2009 saw the launch of the first commercial 4G LTE services in Sweden, the LTE services in Sweden, which afterward extended to the majority of other nations. As a component of the 3GPP specification Release 10 in 2010, LTE-A became standard. To further increased data speeds it made use of more antenna and spectrums. Uplink and downlink data speeds for LTE-A were up to 1000 Mbit/s and 500Mbit/s, respectively. The main components to increase system capacity where carrier aggregation technologies and coordinate multipoint transmission[5].

5G: Mobile voice telephony and mobile broadband data service demands were primarily met by earlier generation (1G to 4G) of technology for mobile communication. Following generation such as mobile communication technology is called 5G. It expands on advantage of earlier mobile communication system generations. The promise of 5G is an enhanced end user experience as well as the opening up of new services, ecosystems and income streams. Higher data rate, less latency, more capacity, and better spectrum usage are anticipated benefits of 5G. 5G can accommodate a variety of usage scenarios and usage is anticipated benefits of 5G. Three kinds among the uses cases for 5G network that are possible, Embb , URLLC, Embb and Mmtc have been established by ITU-R[6].

6G Technologies: 6G technology refers to the theoretical and anticipated sixth generation of wireless communication technology. Building on the foundations of previous generations like 4G (LTE) and 5G, 6G aims to push the boundaries of wireless communication further by introducing new technological advancements and capabilities[7]. Main features of 6G technologies are:

Higher Data Rates: 6G is expected to provide significantly higher data rates compared to its predecessors. This would enable faster downloads, seamless streaming of high-quality content, and enhanced real-time communication.

Ultra-Low Latency: 6G aims to achieve extremely low latency, which is the delay between sending and receiving data. Ultra-low latency is crucial for applications that demand real-time interaction, such as remote surgery, autonomous vehicles, and immersive virtual reality.

Advanced Frequency Bands: 6G may utilize higher frequency bands, including the terahertz (THz) range. These higher frequencies offer greater bandwidth and data-carrying capacity, enabling faster data transmission.

Massive Device Connectivity: 6G is expected to support a massive number of connected devices, catering to the growing Internet of Things (IoT) ecosystem. This involves accommodating sensors, smart devices, and interconnected systems.

AI and Network Intelligence: Artificial intelligence and machine learning will likely play a significant role in 6G networks. These technologies can optimize network resource allocation, predict network behaviour, and improve overall efficiency.

Energy Efficiency: With a focus on sustainability, 6G technology aims to be more energy-efficient, ensuring that the increased connectivity and data demands do not lead to excessive energy consumption.

Global Coverage and Satellite Integration: 6G might extend connectivity to remote and underserved areas through satellite networks and innovative solutions. This would contribute to broader global coverage.

Innovative Applications: 6G could enable novel applications and experiences, such as advanced holographic communication, immersive mixed reality, and more sophisticated augmented reality.

Security and Privacy: Anticipating the continued growth of data sharing and interconnectedness, 6G will likely prioritize robust security measures and enhanced privacy features.

Vision of 6G

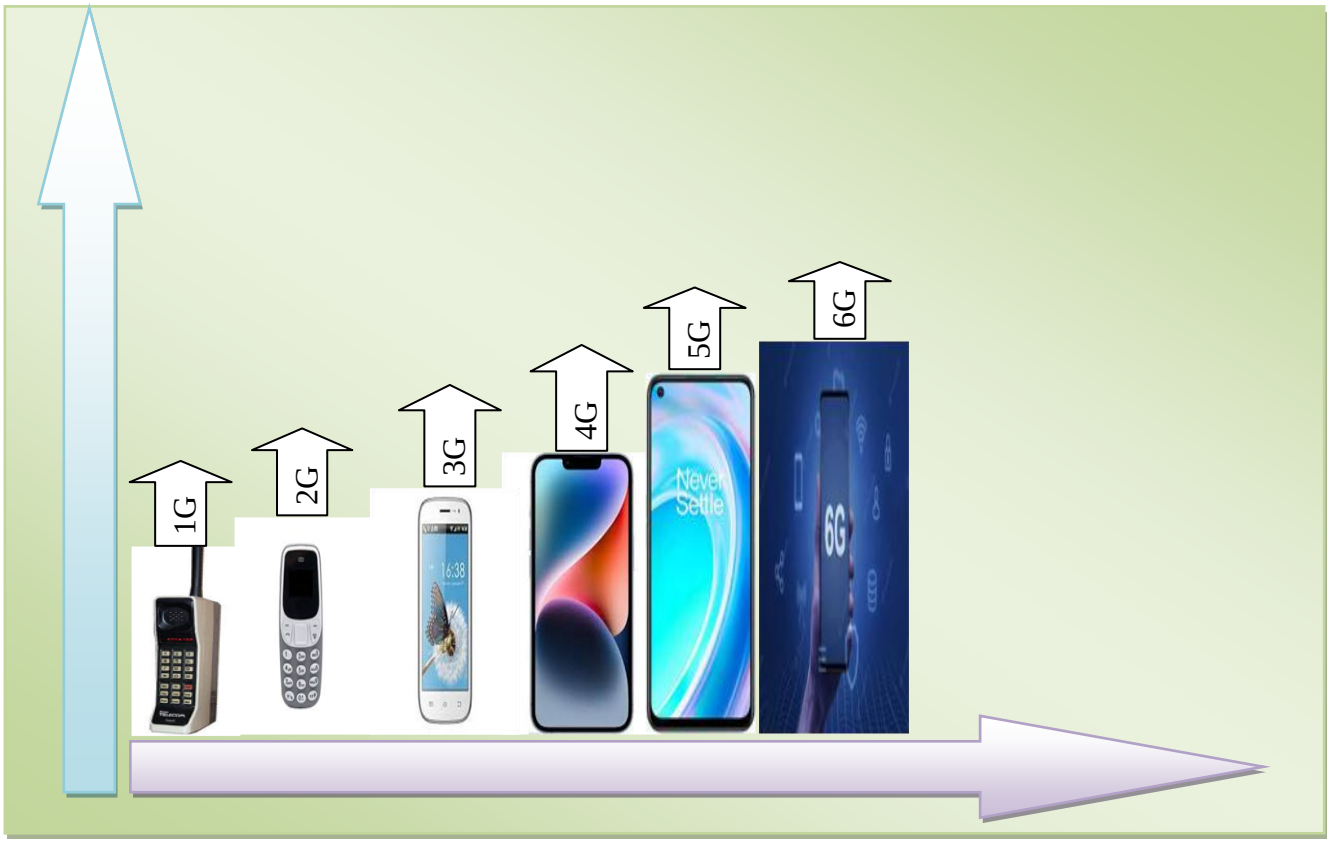
This goal for the sixth generation networks aims to substantially improve current wireless communication structures, improve the standard of service, and meet the needs of huge data flows. The goals of 6G networks are to increase data rates, decrease energy consumption, improve broadband connectivity and coverage, boost link dependability, lower latency, and accomplish intelligent communication. The sixth generation may be able to provide an extraordinarily high data rate of above 100 Gbps with an end-to-end delay of less than 1ms. The exceptionally high levels of communication reliability are also anticipated to be met by 6G. Additionally, with the advent of 6G networks, we anticipate entering the hyper era6G networks are anticipated to offer ultra-low latency and ultra-high dependability wireless communications. Future 6G networks want to allow extremely quick mobility as well. 6G networks are anticipated to use ultra-high speeds and ultra-large-scale MIMO systems combine to enable extremely fast wireless transmission of data.

Additionally, 6G networks hope to handle streaming of ultra-high definition video and offer ultra-high broadband access a conceptual representation of the transition to the hyper age in the upcoming 6G networks.

Using an employment of new, advanced, very smart correspondence systems 6G standards can be met. Examples of crucial techniques needed to maximize data rates include the usage Featuring hologram the airwaves, extra-big MIMO, novel bandwidth, and customizable smart surfaces communications, multi connections and full-duplex in mobile communication, Moreover, modulating In order to increase energy efficiency, backscatter communication techniques and energy harvesting are also necessary. Combining connections from earth into space as well as Large MIMO networks without cells can efficient techniques use boosting communication as well as ensuring complete acceptance? Block chain technology also quantum communication are efficient methods to boost communication security, secrecy, and privacy. Hologram transportation with computing at the edge (telepathy) is helpful methods for developing an ultra-reliable and low-latency connection.

And finally, the realization of intelligence requires the use about machine instruction and computational intelligence. The goal of the sixth generation is coming will seamlessly integrate several wireless networks. This comprises the incorporation of aerial, sub aquatic, and satellite-based wireless networks that are both terrestrial and other non-terrestrial.

A usable venue to communicate interaction full coverage strong access to the internet is made possible by the seamless network integration. In contrast to earlier Wireless communication systems, networks with 6G, include anticipated to provide assistance a variety of apps that are delay-sensitive, including extended reality (XR) has several senses, that combines augmented reality (AR), mixed reality (MR), and virtual reality (VR), as well as the tactile internet and holographic teleportation (telepresence). Smart cities, smart radio environments, smart healthcare, smart grid, smart transportation, smart factories, smart farming, and smart homes are some of the IoT applications. It is anticipated that 6G wireless communications networks would completely support all of these smart applications[8].



1980	**1990**	**2000**	**2010**	**2020**	**2030**
2.4 kbps	64 kbps	2 Mbps	100-1000Mbps	1-10Gbps	1 Tbps
Voice calling	SMS	Internet	Internet of Application	Massive broadband & IoT	New spectrum, Call-less network, Energy efficiency , AI

Figure-1: Generation of Movable Connectivity.

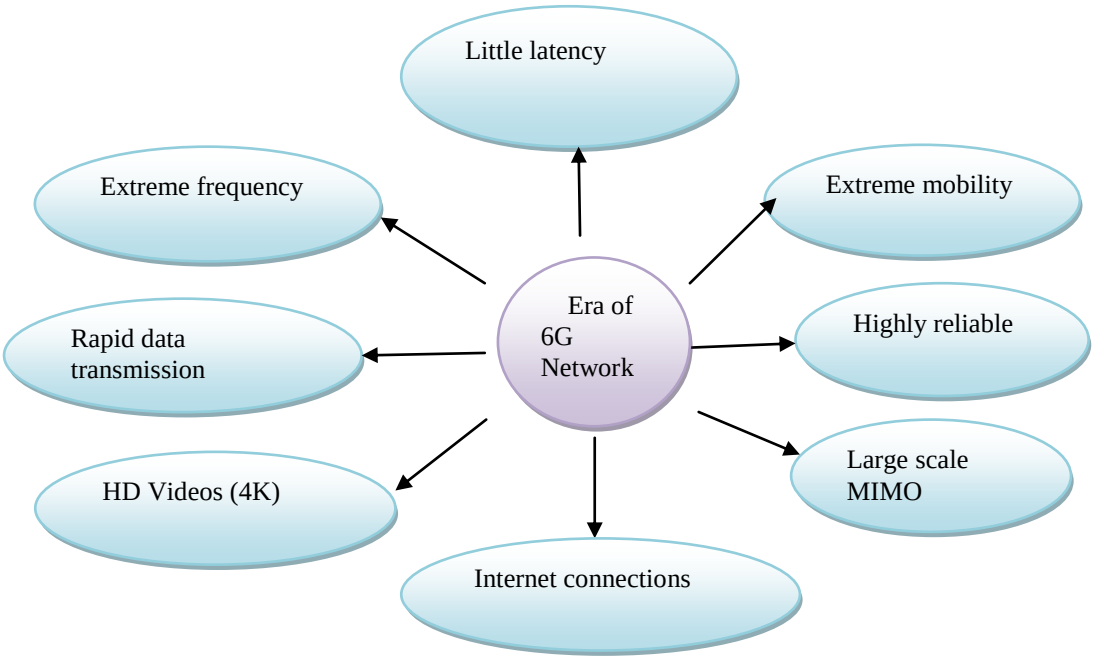


Figure-2: Ultra Era in 6G Network.

Table-2: Vision of 6G Wireless communication[9].

Service	Performance Indicators	Applications
MBRRLC	1. Strict requirement for rate, reliability and latency. 2. Effective energy use. 3. In mobile situations, rate reliability latency	1. XR, VR, AR 2. System for autonomous vehicles 3. Drone with autonomy 4. Inherited URLLC and eMBB
mURLLC	1. Very high dependability. 2. Wide spread connection. 3. Extreme URLLC	1. Traditional IoT 2. User monitoring 3. Block chain with DLT 4. Wide sense 5. Self-driving robotics
HCS	1. Row wireless metrics, as well as environmental and factors are captured by QOPE	1. Compound formed 2. Remainder of the decade 3. Communication with empathy 4. Emotional communication
MPS	1. Consistency 2. Response time 3. Perfection accurate 4. Catching and planning accurate 5. Reaction time and consistent commands 6. Strength	1. CRAs 2. Tele care 3. Green mapping and seeing 4. Some case uses XR services.

Using sixth generation technology's support, users should possess the ability to receive intelligent, personalized, and task-based services whenever and wherever they choose. In home cars, building, factories, cities, and other location, there will be deployed billions of wireless devices including sensor and mobiles. When necessary these devices routing connected to the network. Through interaction with data centres each with strong processing capabilities, meaning information is created for each activity that is required. Thus the impending 6G will usher in a shift in thinking, but only linking not only wireless gadgets but promptly delivering optimum data in response to every unique requirement from consumers in a particular setting. One possible idea for 6G is to offer Brand new intelligent connectivity.

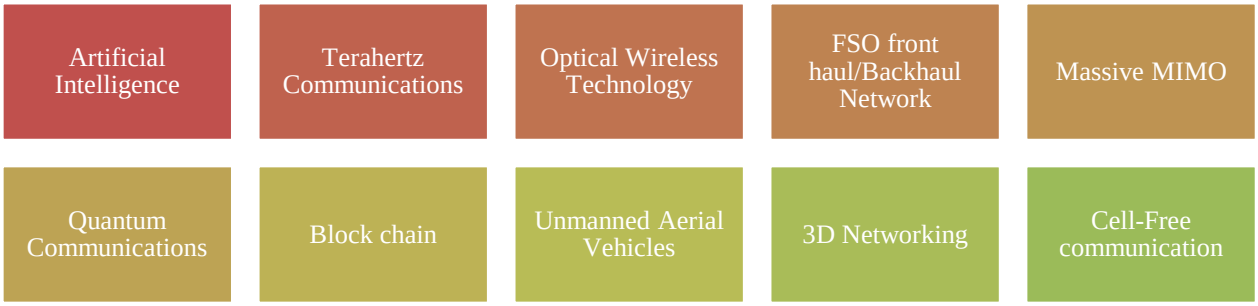


Figure-3: Enabling Technologies of 6G.

Artificial Intelligence: Intelligent autonomous network make up 6G networks. Artificial intelligence via is a significant and newly developed technology that must succeed in 6G communication system. Artificial intelligence was not implementing in 4G communication network. The forth coming 5G communication technology will only support very small part of AI. However automation by AI technology 6G with AI will fully use radio signals in additional to facilitating the transition cognitive to intelligence. Machine learning will make smart network essential for real time 6G communication. AI integration for communication will easier and better data transfer[10].

Terahertz Communications: It is possible to raise the bandwidth to boost spectral efficiency. This can be accomplished by using a greater bandwidth and contemporary Massive Input Multiple Output (MIMO) technologies. With the arrival of mm Wave frequencies in 5G, new application are made possible. 6G intends to expand the frequency spectrum to THz in order to accommodate an even greater demand. Since the RF spectrum has been used to its full extent there is no more spectrum available to satisfy the high needs of 6G. The THz frequency will be crucial for sixth generation communication. In the THz spectrum communication at high data rate are anticipated. The term ‘’sub millimetre radiation‘’ is another name for the THz frequency band. Typically it alludes to frequency range between 0.1 to 10 terahertz having a wave length in the range of 0.03 mm to 3mm. The combined interference elements and significant loss of propagation. The mm wave THz bands, and experience can be lessened by the formation of super narrow beam. To combat the severe air attenuation we will deploy highly directional pencil beam antennas for the band communication[11].

Optical Wireless Technology: For all potential device to device network including those that network to network and network to backhaul network connections RF-based and wireless communication are both targeted applications for the OWC architecture. Utilizing OWC technology 4G communication system is used. It is anticipated that more people would use the technology to satisfy the demands of 6G communications. Visible light Communication (VLC), brightness dedication and optical camera interaction are some of the most well know OWC technologies. These technology are anticipated to be used in a number of application including VR, underwater OWC, V2X connectivity, and internal mobile robot placing[12].

FSO front haul / Backhaul Network: Due to difficult terrain and complexity optical fibre backhaul network access is not always an option. Moreover, it could not be cost-effective to set up optic fibre connections to micro Mobile phone networks. For 5G networks for interaction, with an interface/this connection may be advantageous. In term of transmitter and receiver properties an optical fibre network and an FSO system are identical. Consequently the FSO work structure had capacity to transfer data at a rate similar to that of an optical fibre system. In conclusion FSO works well with optical fibre system. In conclusion FSO work well with optical fibre networks as a backhaul and front haul connectivity solution for 6G[13].

Smart Reflecting surfaces and Massive MIMO: Massive MIMO systems will make it simpler for the smart generation network provide UHSLLC, MMTC, and UHDD operations. The first essential method for raising spectral efficiency is MIMO. The MIMO technique also results in the development of spectral efficiency. Massive MIMO will therefore lead to increased data frequencies and rates for the 5G and 6G systems as well as improved spectrum efficiency and energy efficiency. In order to provide wider surface for wireless communication and diverse device than 5G, we anticipate that wireless 6G system would convert from massive MIMO to integrated radio services. It is a newly created using technology tremendous possibility of green energy- Worked efficiently. The maximum level of wave guiding accuracy is provided by massive MIMO for locating a genuine user. As a result information may be routed to unexpected place (such as Eve). Massive MIMO in contrast to regular MIMO has number of drawbacks[14].

Quantum Communications: The possibility for unsupervised reinforcement learning exists in 6G Network. The supervised instruction method cannot be used to label huge amount of 6G data. Unsupervised learning does not require labelling. Therefore this method can produce complicated network representations a totally autonomous network can be run. Initially it was believed that Quantum machine learning and quantum computing would be crucial elements of 6G technology[15].

Block chain: Block chain technology are crucial for managing enormous amounts of data in upcoming communication networks. The technology used to generate block chains is called technology of distributed ledgers. A spread register, which consists of an information system, has numerous computing devices or nodes. Every stem duplicates plus stores same copies within the register. A Chain of blocks can made up of data blocks that are grouped together, and the links between the sections are encrypted for security. This enormous IoT is natural match for the block chain due to its enhanced safety, privacy, interoperability, stability, and scalability.

Drone Technology Systems: UAVs or drones are crucial for 6G wireless communication. In several instances, UAVs are employed to give high-speed wireless communication. In Drones, BS entities provide cellular connectivity. UAVs possess specific properties with technologies that are transportable, including ease of implementation, straight-line visibility communication, a degree absolute liberty added to controlled movement, in contrast to fixed BS infrastructures. The development of terrestrial communication infrastructure during emergencies like natural disasters is Unsuitable financially and occasionally yes, that's it impossible for providing whatever type of assistance within unstable circumstances. Using These technological, core Standards needed for mobile networks, including MHSLLC, UHDD, and MMTC, can be met, which will transform how wireless communication is performed in the future[12].

3D Connectivity: Consumers of a 6G system's vertical enlargement will able to communication utilising both terrestrial and aerial network. 3D BSs are launched into orbit using satellites and UAVs. Because height and degree of freedom are introduction three dimensional networks are very different from traditional two dimensional networks. We can actually achieve smooth worldwide connect and through even in the hills and seas UAV to the decentralised 6G networks which incorporate terrestrial, UAV and satellite technology[16].

Free connectivity: Many frequencies and various technologies must be tightly integrated for the 6G system to work. By doing this, users can smoothly switch between networks without having to change the setup of their devices. Conventional cellular networks when connections where transverse are mutually exclusive, however the sixth generation is expected to usher within an idea with unicellular networks, as well as non-symmetrical exchanges will become outdated as a result of advancements in technology.

Challenges and Future research directions

There are number technological difficulties that must be resolved as the adoption of 6th G information exchange system to achieve success. Here are just few possible concerns[17].

High Atmospheric Intake and THz propagation: The fast data rates are a result of the high THz frequency. Despite it high propagation loss and low air absorption in THz band make it difficult to transmit data over relatively large distances. The THz communication system Require a revision of the structure for transceivers.

The transceiver must operate at high amplitudes in order to make best of the widely accessible bandwidth. Another obstacle to THz communication is that the antennas for the various THz bands have very little gain and effective area. Additionally THz band communication related Considerations about health and safety must be considered.

Limitations of Heterogeneous Hardware: The 6G network will use a diverse communication in its many forms system, including various frequency ranges, network architectures, and delivery methods. The equipment configuration the ease points also, mobile terminal will differ. Massive MIMO will require an architecture upgrade to support 6G, which will be more difficult. Algorithms and communication protocols will also be difficult. AI and machine learning will also be discussed in a communication.

Autonomous Wireless Systems: Using 6G technology, AI Based industry 4.0 systems, UAVs and autonomous vehicles will all be fully supported. We must integrate numerous diverse subsystems in order to construct autonomous wireless system. Autonomous cloud interoperable processes systems of system the development of the total system consequently become extremely difficult[18].

Modeling of Sub – mm Wave (THz) Frequencies: Absorption and dispersion effects are seen as air conditions influence mm Wave and sub-mm Wave (THz) propagation. The climate is quite unpredictable because of how frequency it changes. Since there isn't a proper channel model for this band it has a highly complex system.

Functionality of the gadget: This sixth generation network could offer several fresh functionalities device like smart phone should be able to use Recent features. Especially facilitating Tbps performance, artificial intelligence (AI), augmented reality (AR) also integrating detecting and communicating feature utilizing separate device will also cost more. The 5G network is anticipated to be used by billions of devices. When switching from a 5G to a 6G communication infrastructure ,5G device

compatibility because it make things and allows for cost savings.

Access to Massive-Capacity Backhaul Networks: In 6G the having to follow: IoT of access networks. Additionally these access networks have a remarkable geographic dispersion and variety. For various user categories there will be numerous access network with quick data speeds. 6G Backhaul networks which connect the access network are potential alternatives for high speeds backhaul connectivity any increasing in the extent to which they network shall be difficult a meeting the 6G standard's expanding demanded data.

Spectral range control and interference management: Give the short age of spectrum resources and interface difficulties it is crucial to manages spectrum assets effectively sharing of the spectrum included schemes similarly cutting- edge spectrum control system. The range of must be managed effectively for maximum QoS and optional resources use[19].

Managing Beams for THz Communications: By employing big MIMO systems and beam forming higher data rates can be achieved. Beam control at sub-mm waves region or in the THz band difficult for massive MIMO systems to manage beams against unfavorable properties of propagation. For a smooth handover in high- speed vehicle, systems, efficient beam selection is also crucial[20].

Security at the Physical Layer: Human-centric communication are essential to many 6G application that to empower people. Privacy and security must coexist. The 6G network's distinguishing features. The safety aspects of 5G network such as decentralization, openness, data interoperability and privacy concern are still up for debate. The 6G network's physical security cannot be maintained using the current privacy rules and procedures.

Economic Prospect Planning: 6G communications deployment is also necessary in addition to economic possibilities. The installation of 6G will result in increase infrastructure expenditures. However with careful planning upgrading a 5G network to a 6G network may be less expensive. Incredibly crucial a research Potential of sharing information, facilities plus frequency in order to make 6G cost- effective.

Table-3: Potential 6G features compared to 5G[21].

Major Factor	5G	6G
Reliability	FER 10^{-5}	FER 10^{-9}
Peak frequency UL	10Gbps	~1Tbps
Peak DL Frequency	20Gbps	1Tbps
user interface	50Mbps 2D	10Gbps 3D
Localization Accuracy	10cm on 2D	1cm on 3D
Traffic density	10 Mbps/m2	10Gbps/m3
Energy efficiency	NS	1pJ/bit
Latency	1msec	0.1msec
Jitter	NS	1uSEC
Receiver sensitivity	About-120dBm	<-130dBm
Positioning precision	Meter level	Centimeter level
Delay	Ms level	<1ms
Connection density	1million/km^2	>10million/Km^2

Trends and 6G Specifications

Below mention are some of the main applications of 6 G specifications[22].

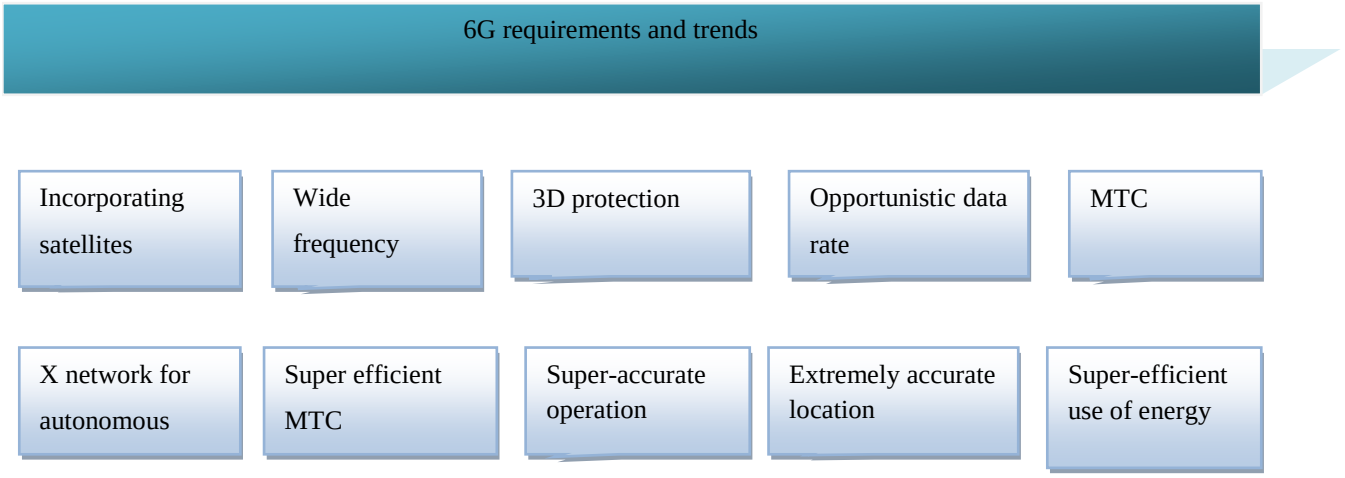


Figure-4: 6G Requirement and trends.

Broad frequency band: It is clear that the needs of the 6G use cases necessitate the utilization of broad frequency bands. The QoS and QoE requirements may not be supported by the frequencies allocated to NR. Future networks are therefore expected to operate at higher frequencies Such as 73GHz, 140GHz, 1THZ and 3THz[23].

Unpredictable data rate: To enable new application including engaging multimedia. It is necessary to have a very high peak data rate. Opportunist 6G latency channel's and delay between ends must be under one millisecond. By bringing down latency to almost nil, XR services quality of services must be increased. Tele presence also need to latency that is less than sub-millisecond.

MMtc: Numerous linked devices will require 6G's support. The present tendency such as human centric solution won't work because of how complicated the network and how many devices are connected. There is a need for a new trend that is machine-centric for such a big number of gadgets. Moreover, minimal latency and large data rates communications. To accomplish this goal 6G network must adhere to stringer standards such high availability, extremely low latency and reliability.

Incredibly precise operation: It's evident that the conventional multiplications of statistics approaches are insufficient to handle future services and application that demand great precision. Tele surgery and intelligent transportation systems are two examples. this kind of services or application demands extremely accurate and excellent performance such as timely delivery.

X network for self: In comparison to earlier generations, a 6G network needs to be more durable and adaptable. Humans are unable to regular the robustness and flexibility of these networks. There for Machine learning (ML) Techniques are crucial for controlling such intricate networks. Network autonomy can be promoted and knowledge of their operating environment can be gathered by adopting ML techniques. The 6G network will employ ML algorithms to Independently self-made, self-optimize, self-aggregate, self-healing, then develop themselves[24].

Incredibly accurate placing: Using the Global positioning system a position is determined by signal strength and journey time. According to the inaccuracies they experience these services precision in meters is below average. Future will require sub millimeter positional accuracy precision. They include tale surgery and tactile internet services.

Higher energy effectiveness: The energy consumption of devices using 6G is frequencies is considerably more than that of 5G devices. Energy harvesting since illustration works for address the problem of 6G's sustainability.

3D Coverage connectivity: When using 6G application users will have access to a 3D holographic display. Both terrestrial and aerial device can be used to access these services.

The sixth generation Application

This section goes through some of the most important new applications that will rely on the capabilities of a future 6G network25.

Internet of Everything (IoE): IoE, which encompasses things, data, people, and processes, is an expanded version of IoT. The core idea behind the Internet of Everything is the integration of numerous sensors that's capable of connected "everything" to identification, status keeping an eye at all times intelligent decision- constructing to open up new opportunities. Many metrics, comprising bio signals, pressure, heat, location, sunlight and speed data, can be acquired by IoE sensors. To enable decision support systems, these detectors include employed uses found in the travel, urban planning, medical care, or manufacturing domains. Additionally, it is anticipated that the merger of IoE with 6G connectivity would lead to the development of numerous new applications. However, it is expected that IoE would rely on 6G since it requires the capacity to link N-intelligent devices—a figure that could reach

billions—where N is expandable. Additionally, For IoE to function properly and enable multiple devices with low delay, large data rates are needed. 6G and the Internet of Everything could. Therefore help corporate procedures generate enormous amounts of information as well as reinvent digitization through more effective and flexible data analytics. Al concentrated on the possible sensors that might be utilized to integrate the Internet of Everything and 6G networks to connect the viewpoints of connection via digital and physical channels. He did this by merging IoE and 6G characteristics into a distributed AI as a service (DAIaaS) architecture.

Power Intelligent 2.0: Power intelligent 2.0 combines cognitive choice-making tools utilizing intelligent meters so that intake may have precisely tracked. In addition, In order to fulfil the increasing need for energy, intelligent grid 2.0 seeks to detect interruptions, measure power quality, apply demand management, and link to the system. Since managing and keeping an eye on electricity from a distance requires a large number of linked items, communication has been one of the obstacles in the development of the smart grid. To execute such a control technique, the system requires connection control of resources, safety, and excellent transfer. For the purpose of providing excellent services and a dependable supply, all physical items, structures, converters, and various other parts need to be recognized and kept an eye on. The 5G connectivity currently meets the demanding bandwidth as well as low latency requirements for the financial viability of the intelligent power grid project with a limited number of sensors. Due to the lack of data and fictitious scenarios investigated prospective applications and developments linked to the progress made in merging 6G with intelligent grids are quite limited. 6G communication systems include computation, connectivity, networking, and important enabling capabilities.

Holographic Telepresence: HT has the ability to project very practical, high-definition, live-action 3D visuals of distant people and things that are on par with their physical existence. It can be utilized for applications like TED talks, Newscasts in continuous motion and 3D conference calls etc. In the beginning, HT records video of individuals and their surroundings, this is after which it is squashed and delivered via a high-speed connection. In early receiver's end, transferred subsequently, information is displayed and reduced with beams of laser light. Tactile and interactive material are essential for engaging the audience, and HT reduces business trip expenses and permits individuals to present in multiple locations at once.

Conversely, though there are several obstacles impeding the uptake of HT technologies. A primary challenge that 5G largely tackles is the requirement for extraordinarily low latency (1 ms) and massive data speeds of 10 Gbps. A completely unperturbed, complete immersion requires 6G, which has a latency of 0.1 ms and a data capacity of many Gbps, Picture transmission from multiple viewing cameras, which necessitates much increased rates of data are the foundation of holographic communication. With 5G, this is doable with a few restrictions, such as limited or no mobility and specialized network resources. The next-generation network, or 6G, will have substantial connectivity issues due to people's penchant for high-fidelity remote communication.

Accessibility Utilizing UAVs: UAVs have occurred widely using defence services, including autonomous drones and remotely operated planes. UAV applications have grown over time in both the military and civil fields. For instance, UAVs have been suggested for environmental detection, traffic surveillance, agricultural plant protection, and disaster assistance. Upcoming networks, such as 6G, will allow remote communities to communicate at rapid speeds of data. Confronting crisis events like earthquakes and terrorist attacks, and without the conventional cellular infrastructure presence, are also predicted to depend heavily on UAVs. When compared to fixed infrastructure, line-of-sight (LoS) connectivity, ease of deployment, and, most crucially, controlled mobility are key advantages of UAVs.

Growing UAV applications in the telecommunications industry, incorporating connection entrances, live data broadcasting, and relay BSs, are projected to propel the growth of the UAV industry. First of all, an achievement was reached employing UAV for quantum communication. The potential use Using UAVs in a hot area, crowded areas, and as relay-BSs constitutes a fundamental component of the networks of the future. They exposed a quantum network with UAV-based entanglement distribution. Lately, a great deal of effort has gone into producing creating extremely flexible interconnected networks[26].

Xtended Reality: The physical and digital worlds are combined using a new technology for immersion termed XR generating human-machine interactions through wearable devices and computers. Different sensors are used by the utilizing all four platforms (MR, VR, XR, and AR) to obtain position, guidance, and acceleration data. This requires very fast data rates, excellent resolution, and very low delay, all of things 6G is anticipated to enable. In every kind of MR, XR, VR, and virtual reality, latency is crucial. it enables massively low latency instantaneous viewer engagement into a fully realistic setting, with 5G is used data throughput must reach Tbps rather than Gbps.

Connected and Autonomous Vehicle: Academic and commercial areas have shown a great deal of excitement in future infrastructure, such as self-driving cars, collaborative automobile networks, Web with Automobiles Vehicle ad hoc Connections (VANETs), air-to-ground relationships, and orbiting air-ground networks that are linked together. These vehicle-related processes in particular lay the path for smart communication via V2X and the upcoming 6G Smart Transportation Network (ITS), as well as an AI-enabled future vehicle network. It is anticipated that CAV will be a crucial

component of several important technologies, including 6G, AI, and DLT. Cooperative vision, smart crossings, and smart paltering are examples of CAV applications that can significantly improve traffic congestion, fuel efficiency, and road safety.

Industry 5.0: Industry 5.0 Enhance Industry 4.0's, efficiency and automated foundations with an individual approach by working with computer and intelligent technology. The primary innovations that enable Industry 5.0 to operate are anticipated to be Similar to Industry 4.0, cloud/edge computation, massive data sets, artificial intelligence, the sixth generation, as well as the Internet of Everything. Within particular, Industry 5.0 relies on a vast quantity is interconnected devices that can be wired or wirelessly connected Offering a range of apps and services that are enabled feasible by the seamless combining artificial intelligence, massive data sets, and cloud/edge technology.

Despite the lack of a clear definition and standard for 6G, a lot of research has been done to determine how 6G systems and technologies can help with Industry 5.0's problems. Industry 5.0 is regarded a crucial application for the sixth generation, in which processing, information, authority, or storage key all collaboratively enhanced in addition to communication. Robots are projected to grow Advanced as result on the sixth generation connectivity and advancements in AI technologies, which will create enormous amounts of data from gigantic objects. Additionally, 6G's numerous potential technologies, including Rob copters and detectors in Industry 5.0 that have limited energy sources will have viable options thanks to mobile power movement, capture of energy, and scattering networking.

Extremely Smart IoT: Next-generation IoT apps with extreme intelligence can incorporate digital assistants, robotic devices, and UAVs in addition to AI techniques to improve data processing in order to provide more intelligent and smart services. It is crucial because there will be a vast quantity for Internet-connected IoT gadgets and to one another, which will generate a enormous quantity mobile details needs to processed intelligently at the connection boundary. According to data, the overall data traffic produced by edge apps, devices, and other objects is 850 ZB, as opposed this represents 20.6 ZB of total server bandwidth. Supporting networking edge information, sometimes referred to since edges intellect, or edges AI, possesses the capacity to offer a variety of workable treatments & remedies of highly the Internet of Things[27].

Collaborative Robots: Collaborative machines, work alongside humans in order to directly collaborate with them. To safeguard people health and safety of employees, as well as automating operations manufacturing lines, these cobots take over tiresome, risky, and repetitive activities. Although cobots have many advantages, using Industrial 5.0's autonomous machines requires cutting-edge responses for dependability, security as well as faith. Additionally, in order to enable new applications, cobots must process enormous quantities details and arrive at choices instantly, which are often impractical owing to storage space, computing power, and connectivity issues. Wireless charging is incorporated into the cobot concept as a whole Specifically, one robot is utilized to remotely charge neighbouring powered gadgets, as well as robot's computational job is delegated Access the internet in order to conduct processes remotely. Before being used, this system must first be pre-trained offline[28].

Individualized Local Region Systems: The monitoring and management of individualized health is getting closer thanks to Body Area Networks (BANs) as well as integrated mHealth (mobile health) solutions. These specially designed BANs are able to collect health information from a variety of detectors, transmit it with the environment rapidly, and connect to communication platforms like social media. Applications for There are several customized BANs for both beneficial as well as healthcare uses fields. The development of nano-sensors has received some attention in the pursuit of IoBNT. Highly sensitive capacitive nano mechanical sensors are created using grapheme membranes and are demonstrated to respond more quickly than commercial nano-sensors. Several key obstacles in IoNT and IoBNT, such as handling data, practical confirmation, system as well as transport protocols, usage of energy, disturbance oversight, code plan, modulating strategy, have been highlighted from the standpoint of wireless communication. In addition to extras initiatives through continuing research into IoNT and IoBNT, the characteristics of 6G include To get above these obstacles, high information performance, dependability, fresh wavelength (visible light and THz) interactions, including extremely low latency would be helpful. An interaction perspective, as well as data rate, bandwidth of channels, delay in propagation are investigated for the individual's insulin-glucose network.

Intelligent Healthcare: Similar to the commercial progression from the beginning of Industry 1.0 to 5.0, these are multiple changes in the creation of medical care that is currently Medical 5.0 alongside the growth of electronic healthcare. based on artificial intelligence smart healthcare can be developed by making use in Quality of Life (QoL), Intelligent Wearable Devices (IWD), IIoMT, H2H assistance, as well as novel business approaches. The ability to continuously track and evaluate wellness information has recently been made available by advancements in wearable sensors and computing equipment. Healthcare 5.0, or intelligent healthcare, is made possible in large part by 6G. Promising technologies in particular are anticipated to be important, include haptic the internet, smart edges (i.e., cloud/edge technology + AI), hologram interactions, and IoBNT . As the amount of medical information keeps increasing, using AI (such as deep learning) to generate intelligence-driven medical products has become an important phenomenon in medical advancement. Dramatically Precision medicine, telesurgery, and IIoMT are just a few of the intelligent healthcare services that 6G has the potential to offer[29].

Conclusion

Since the development and implantation of 5G network is almost complete, 6G networks have moved to top of many academics priority list. The 6G network will upgrade network services compared to earlier generations. With each generation, communications systems have more and more intriguing new features. By 2030, 5G will lack the capacity in adequately Talk over the internet communication market's continuous growth. Therefore 6G must be put into practice. This paper provides brief summary of security and safety issues concerning 6G networks. It has started by going from 1 G to 5 G. 6G communication applications and technologies are examined in this research. Difficulties and future directions of 6G research are also discussed.

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